HANDBOOK FOR BURIED CABLE FAULT LOCATOR MODEL 2775A TEST SET

RYCOM® INSTRUMENTS

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See Addendum Page 27
For Instructions for use on Aerial Cable.

SHOULD YOU HAVE TROUBLE

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Ask for "Gene Tuel"

Figure 1. Buried Cable Fault Locator, Model 2775A Test Set

INTRODUCTION

The RYCOM Instruments Model 2775 Test Set, shown in Figure 1, is used for locating, path, depth, and faults such as, "shorts," "grounds," "splits" "wet spots," and "cuts," in buried cable plants. The Test Set consists of a Transmitter and high sensitivity Receiver/Amplifier with headset. The various probes utilized to locate faults, etc., are not supplied as part of the Test Set but are available for separate order.

Table I lists the accessory probes and describes briefly the functions or specifications. The probes are supplied as accessory items to enable the user to select that probe or probes most suitable for his intended application. It is possible to utilize accessory probes from similar test sets if careful attention is given to the impedance and other specifications before attempting to use such accessories.

TABLE I. ACCESSORY PROBES

Probe	Description	Figure Number
Snooper	Highly sensitive, directional probe utilized for location of path, depth, high resistance "crosses," and "shorts".	Fig. 2
Locator Wheel	Sensitive probe for low resistance "shorts," "crosses," and "splits."	Fig. 3
Return Ground	Ground current probe for measuring ground current in location of "grounds", "cuts", and "wet spots".	Fig. 4

The transmitter generates either a steady or interrupted tone for application to the cable under test. The receiver together with the selected accessory probe and with the headset connected is used to detect and amplify the tone signal radiated by the cable under test. The receiver headset provides aural monitoring of tone. The transmitter has metering facilities to determine the matching and output for optimum conditions. The receiver has metering facilities to provide a visual indication of receiver signal strength in addition to the aural monitoring provided by the headset. The transmitter and receiver are completely transistorized and designed to provide

minimum battery drain, ensuring long battery life and high reliability under field conditions.

Figure 2. Snooper Probe

Figure 3. Locator Wheel Probe

The Receiver when connected to the applicable probe or exploring coil may be used in locating "grounds," "shorts," "splits," "crosses," "wet spots," "cuts," path, and depth in buried cable plants. The Test Set is not designed to be an effective device for locating "opens," and in the event an "open" is found it should be considered an accident.

A "ground" is a connection between a conductor and the sheath.

A "short" is a connection between two conductors of the same pair.

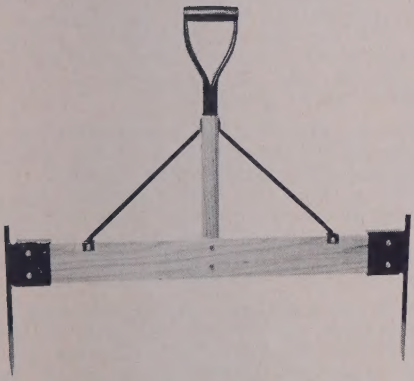


Figure 4. Return Ground Probe

A "split" is the loss in identification of pairs in splicing.

A "cross" is the result of loss in identification of pairs in splicing and shorted in splice.

A "wet spot" is a combination of a "ground" and "short" due to the penetration of moisture through an opening such as a crack or other break in the cable sheath, creating a high resistance ground to conductor, sheath, or earth.

An "open" is a break in the conductor.

A "cut" is a group of conductors which have been severed at an unknown area.

DESCRIPTION OF APPARATUS

The Model 2775 Test Set consists of a transistorized transmitter in a steel carrying case, with a storage compartment containing the headset, portable receiver, and neck strap. The Test Set carrying case is 10-5/16 inches by 7-3/8 inches by 6-3/8 inches in size and weighs approximately 14 pounds with all components of the Test Set in place and the battery installed.

The receiver, Figure 5, is removed from the carrying case and carried around the neck of the operator, for ease of operation and enables the operator to observe meter for visual indication during probing. The headset enables aural monitoring of tone signals detected and amplified by the receiver. The receiver is 3 inches by 3-1/2 inches by 5-1/2 inches and weighs approximately 1 pound with the battery and neck strap.

Figures 6 and 7 illustrate the control panel of transmitter and receiver respectively, for ease in identifying controls and their location. Table II lists the control marking or name and function as an aid to operation.

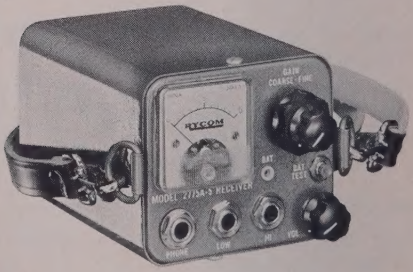


Figure 5. Receiver and Carrying Strap

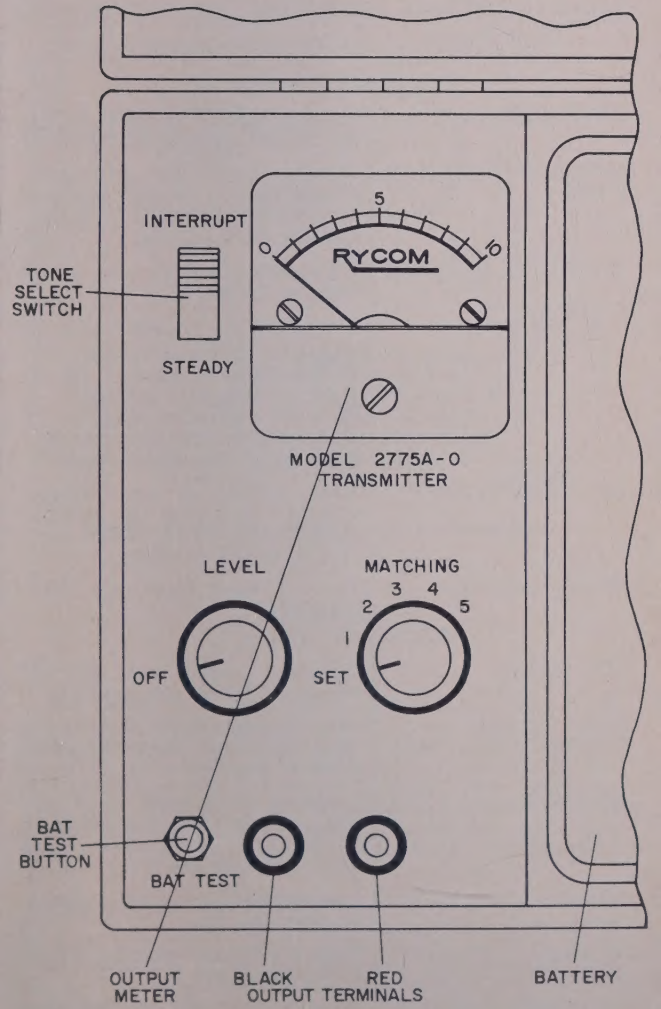


Figure 6. Transmitter Control and Terminal Locations

TABLE II. CONTROL FUNCTIONS AND CONNECTIONS

Control Marking or Name	Function
TRANSMITTER (Fig. 6)	
OFF-LEVEL Control	Applies battery power to transmitter and controls output level.
INTERRUPT-STEADY Switch	Switch positioning determines characteristics of emitted tone. Interrupted tone aids in identification when probing.
MATCHING Control	Six position switch with functions as follows:
Position	
SET	Level adjust position during setup.
1	Load impedance 0-200 ohms approx.
2	Load impedance 150-600 ohms approx.
3	Load impedance 300-1,000 ohms approx.
4	Load impedance 1,000-10,000 ohms approx.
5	Load impedance 10,000-10 megohms approx.
BAT TEST Button	Push button to test battery voltage, indication of battery condition on meter. (Level control is in ON position).
Output connection	Red and black three way binding post.
RECEIVER (Figure 7)	
VOL Control	Controls output level of receiver to meter and headset.
GAIN Control COARSE-FINE	Dual control, small knob-FINE gain, large knob-COARSE gain, probe to receiver.
PHONE Jack	Insertion of headset plug applies battery power to receiver. High impedance headset supplied with Test Set.
LOW Jack	Low impedance input for probe or exploring coil.
HI Jack	High impedance input for probe or exploring coil.
BAT TEST Button	Push button to test battery voltage, indication of battery condition on meter.

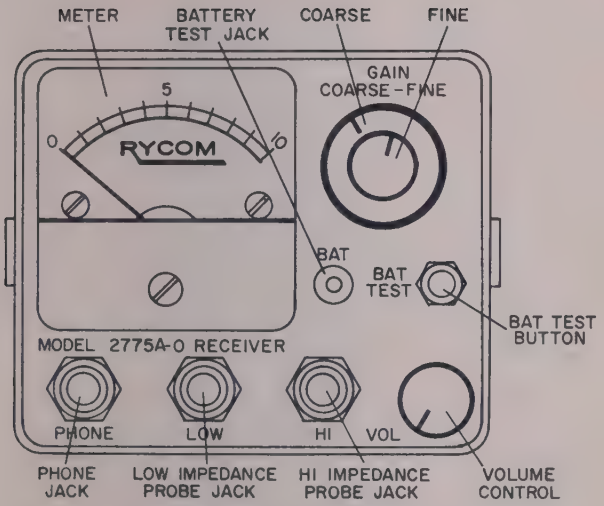


Figure 7. Receiver Control and Jack Locations

OPERATION

General

The Model 2775 Test Set is designed to locate fault in a cable after the general nature of the fault has been determined and isolated between pedestals (test points). Standard procedures of locating the faulted wire of the cable should be used and are not covered in this handbook. Equipment used for tests is standard and available in most plant maintenance centers. *The faulted wire must be disconnected from all signal circuits before connecting the Model 2775 Test Set.*

The transmitter generates an alternating current source (audio tone) for connection to the faulted cable or wire under test, and/or other circuit path, in order that a complete circuit for the audio tone is made. The circuit thus formed permits the alternating current (audio tone) to flow through the faulted wire or cable and return

via the sheath, ground, or other path. The alternating current (audio tone) following develops an electromagnetic field around the cable as shown in Figure 8.

The detection of this electromagnetic field is accomplished by connecting an exploring coil probe, such as the Locator Wheel or Snooper Probe to the low impedance input jack on receiver and placing the probe in a position where detection of the electromagnetic field by induction occurs. This detected signal is amplified by the receiver circuits to drive the meter providing visual indication and the headset providing aural indication. Figure 8 illustrates the relative tone level in relation to probe positioning. The null occurs when the lines of force which are cutting the coil at an angle causes cancellation. Obviously the amplitude of tone detected and the related electromagnetic field will vary with type of fault, depth of cable, and level settings of the equipment.

The same electromagnetic field is present in all tests but is not always the result desired. This is particularly true of tests for "cuts," "grounds," and "wet spots," utilizing the Return Ground Probe. This fault utilizes the sensitivity of the receiver to measure the return currents through the soil to the transmitter. Thus the return path is via the "ground" or "wet spot" to the soil and not through the sheath or another wire of the cable. This results in an area of high current directly over the fault. This area of high current occurs at two points, directly at the fault and at the ground rod connection of transmitter. Refer to Figure 16 for more detailed analysis by graphic presentation.

Test Set Adjustment.

The method of adjustment of the transmitter and receiver for the various tests is essentially the same. Levels and matching will vary considerably from one type of fault to another and with the cable plant under test. The following steps are preliminary and applicable to all tests unless specifically excepted in the test setup procedure. Receiver adjustment is the same for all tests with the only variation being that of probe selection. The connection of probes will be referenced in the applicable test procedure.

1. Transmitter Adjustment.

a. Connect the red and black output terminals to the circuit under test in accordance with the specific test

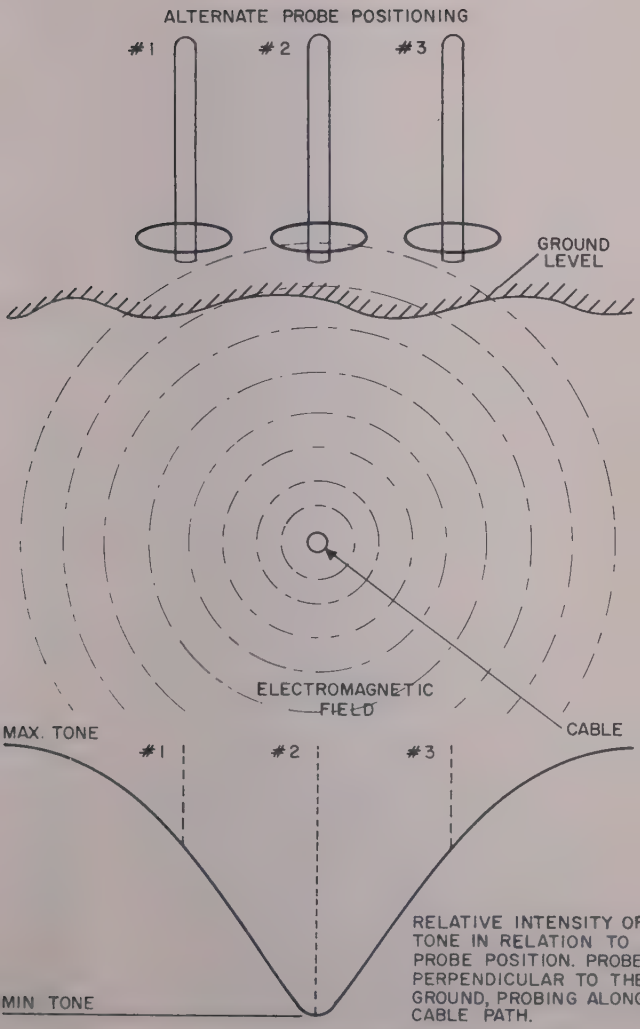


Figure 8. Electromagnetic Field Around Cable

setup. (Caution—do not connect or disconnect leads with transmitter operating).

b. Rotate OFF-LEVEL control clockwise to apply battery power.

c. Place STEADY-INTERRUPT switch in the STEADY position.

d. Position MATCHING switch to the SET position.

e. Rotate OFF-LEVEL control clockwise while observing the output meter. Position control for full scale indication on meter.

g. Position MATCHING switch to that numbered position (1 through 5) which reflects a reading nearest the center of meter range (needle drops back). This condition is indicative of optimum power transfer. (NOTE: Failure of the meter to indicate optimum power transfer is normally attributed to attempting to drive an extremely high impedance line or a line with a high value of capacity. To check for high capacity, position MATCHING control to SET, decrease meter indication to slightly below full scale by positioning OFF-LEVEL control and respositioning MATCHING control while observing meter for a slight upward deflection. The slight upward deflection of meter is indicative of resonance and again indicates that optimum power transfer is occurring).

h. The level output used for each test will differ and is a function of the losses incurred in the cable. A small percentage of cross-talk could result when a high level of tone is applied. The best rule is to use only the output required to locate fault accurately.

i. Position INTERRUPT - STEADY switch to the INTERRUPT position to aid in identification of the tone when probing.

j. Perform battery check with transmitter controls in any position provided OFF-LEVEL switch is in the ON position. Press BAT TEST button and observe meter for indication of battery condition. The meter is calibrated to read volts and should read between 6 and 10 volts. A new battery will read slightly above 10 on the meter. (Indication of 6 or below necessitates battery replacement).

2. Receiver Adjustment.

a. Jack the headset into PHONE jack (insertion of headset plug applies battery power) of the receiver.

(CAUTION—PHONE jack is above ground by the battery voltage of 7.5 volts, inadvertent grounding will shorten battery life).

b. Jack the selected probe into the proper impedance jack: HI for Return Ground Probe, LOW for Snooper and Locator Wheel Probes.

c. Rotate VOL control clockwise to increase gain of receiver while positioning probe in proximity of tone source or cable, carefully move away from tone source and increase gain for suitable level of audibility in headset.

d. With tone indication adjusted to level of preceding step c. move away from pedestal to which transmitter is connected and carefully adjust COARSE-FINE GAIN controls for optimum indication of tone.

e. Position probe for test specified and proceed along cable path per specific test instructions.

Cable Path and Depth Determination.

Utilizing either the Snooper or Locator Wheel Probe, the path and depth of a buried cable may be determined accurately. Figure 9 illustrates a typical extended cable plant and notes the connections which should be made to prepare plant for probing and depth finding. The following steps are those shown in Figure 9 and must be completed before test is started:

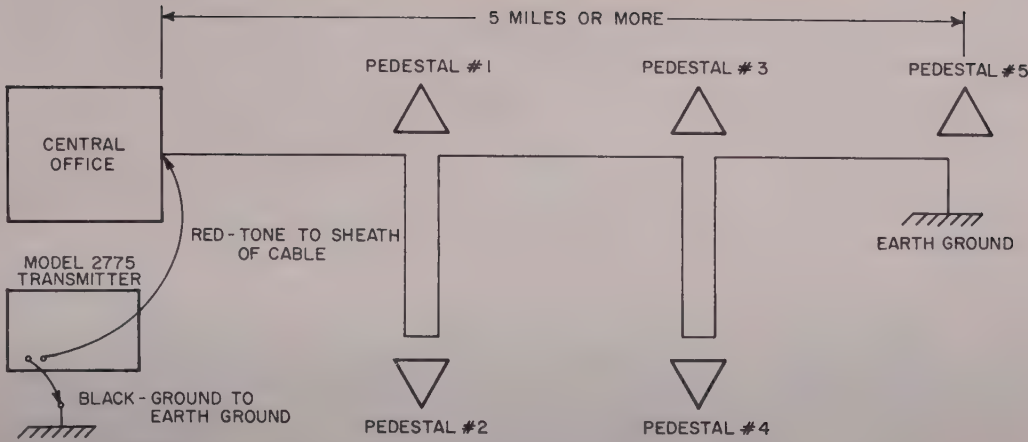
a. Starting at the central office or at a pedestal remove sheath from ground and connect to red output terminal on transmitter.

b. Identify the central office or pedestal earth ground and connect the ground to black output terminal on transmitter.

c. Remove sheath at each pedestal and tie sheath through to the next section above earth ground. Repeat this at each pedestal until desired termination point is reached. At termination point ground sheath to earth ground.

d. Complete transmitter adjustments covered in preceding Test Set Adjustment paragraph.

e. Jack Snooper or Locator Wheel Probe into the LOW impedance jack on receiver and complete receiver adjustments of preceding paragraph, Test Set Adjustments.



NOTE:

REMOVE SHEATH AT PEDESTALS 1 THROUGH 5, TIE SHEATH THROUGH ON PEDESTALS 1 THROUGH 4, AND GROUND SHEATH AT PEDESTAL 5. RETURN GROUND CURRENT IS VIA EARTH GROUND TO THE TRANSMITTER. FOLLOW CABLE PATH WITH SNOOPER OR LOCATOR WHEEL PROBES. OBSERVE METER AND AURAL INDICATION FOR NULL WHEN PROBE IS OVER CABLE.

Figure 9. Typical Cable Plant and Preparation for Path or Depth Determination

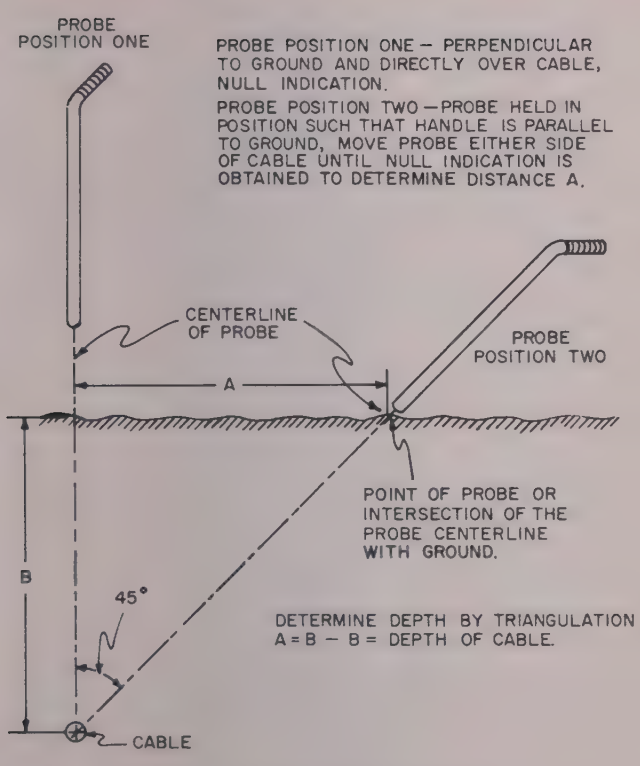

PROBE POSITION ONE
PROBE POSITION ONE – PERPENDICULAR TO GROUND AND DIRECTLY OVER CABLE, NULL INDICATION.
PROBE POSITION TWO – PROBE HELD IN POSITION SUCH THAT HANDLE IS PARALLEL TO GROUND, MOVE PROBE EITHER SIDE OF CABLE UNTIL NULL INDICATION IS OBTAINED TO DETERMINE DISTANCE A.
CENTERLINE OF PROBE
PROBE POSITION TWO
A
POINT OF PROBE OR INTERSECTION OF THE PROBE CENTERLINE WITH GROUND.
B
45°
DETERMINE DEPTH BY TRIANGULATION
A = B – B = DEPTH OF CABLE.
CABLE

Figure 10. Depth Determination

f. For path determination follow cable path shown in Figure 9 by noting the null indication of tone in headset or visually by meter indication. The null condition occurs when probe is directly over cable and perpendicular to cable.

g. Using the Snooper Probe, and referring to Figure 10, determine depth of cable. Positioning the probe in alternate positions one and two as shown determines cable depth accurately by triangulation. (NOTE—The Locator Wheel may be used for depth determination, but due to

the lighter weight and ease of handling the Snooper Probe is generally used).

Location of Faults.

Location of "Shorts".

Either the Snooper or Locator Wheel Probe may be used effectively in the location of "shorts". Figure 11 illustrates a cable section with a short between two conductors of a pair. Normally it is more expedient to determine the approximate location of a direct "short" by the Murray or Varley Loop test (refer to BSP or REA buried plant maintenance manuals).

Direct Metallic or Low Resistance "Shorts" in Buried Plastic Cable.

The following steps when completed should pinpoint the shorted area:

a. Isolate conductors at both pedestals.

b. Connect shorted pair to red and black terminals of transmitter.

c. Adjust transmitter in accordance with procedures given in Test Set Adjustment paragraph.

d. Jack the Locator Wheel Probe into the LOW impedance input jack.

e. Jack the headset into PHONE jack, and adjust receiver for aural indication of tone. (NOTE: This will possibly require more receiver gain than normally used and care should be exercised that the interrupted tone is identified).

f. Proceed to a spot some distance away from the calculated location of fault, proceed toward faulted area noting aural and visual indication of signal strength. The tone will be heard as cable is walked, with a peak when directly over the cable, there will be a picket fencing affect of the tone (due to twisted construction of cable causing a slight rise and fall in the tone level). The tone will remain nearly constant until the faulted area is approached, at which time the level will rise until a point where it will cut off (drop) sharply. At this point the fault will exist.

g. Location of shorts is somewhat limited when using 24 and 26 gauge cable due to the high resistance in this

gauge wire. Tone is sometimes lost since, the current field will be low.

Location of "Crosses" and Splits".

Using either the Snooper or Locator Wheel Probe and following the general procedures outlined in the BSP or REA buried plant maintenance manuals, proceed as follows:

a. Isolate faulted pairs at both pedestals.

b. Connect faulted pairs at distance pedestals together and connect tone to any known pair at the red and black terminals of transmitter. (NOTE: It may be necessary to repeat the procedures of steps c. through f. connecting the tone to different wires alternately).

c. Adjust transmitter in accordance with procedures of Test Set Adjustment paragraph.

d. Jack the Locator Wheel Probe or Snooper Probe into the LOW impedance input jack on the receiver.

e. Jack the headset into PHONE jack, and adjust receiver for aural indication of tone near pedestal, and following the known cable path proceed to a point where the tone is just audible (20 to 50 ft. from pedestal). Readjust controls to setting where tone is inaudible.

f. Proceed along known path of cable until an increase in signal strength is noted (tone will peak), at this point the wires will be "crossed" or "split".

g. It may be necessary to perform steps c. through f. several times to locate "crosses" or "split" pairs, while alternating connections at the pedestal to apply transmitter output.

h. Limitation with 24 and 26 gauge cable, same as short location. Repeat step g.

Location of "Cuts", "Grounds", and/or "Wet Spots".

Using the Return Ground Probe, "cuts," "grounds," and/or "wet spots" may be located within inches. Figure 12 illustrates the return ground currents flowing when a "ground" or "wet spot" exists. Figures 12, 13 and 14 illustrate a section of buried cable and the method of connecting transmitter for various suspected faults.

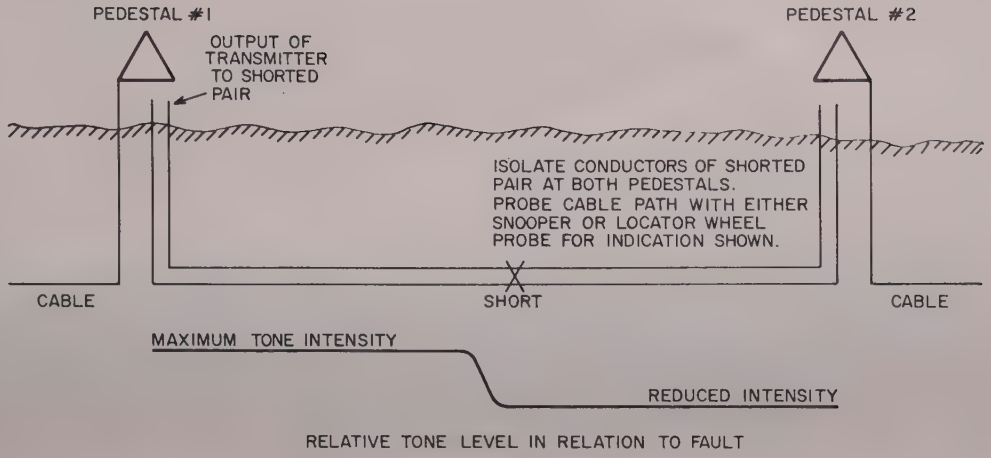

PEDESTAL #1
PEDESTAL #2
OUTPUT OF TRANSMITTER TO SHORTED PAIR
ISOLATE CONDUCTORS OF SHORTED PAIR AT BOTH PEDESTALS.
PROBE CABLE PATH WITH EITHER SNOOPER OR LOCATOR WHEEL PROBE FOR INDICATION SHOWN.
CABLE
SHORT
CABLE
MAXIMUM TONE INTENSITY
REDUCED INTENSITY
RELATIVE TONE LEVEL IN RELATION TO FAULT

Figure 11. Cable Plant with Shorted Conductors

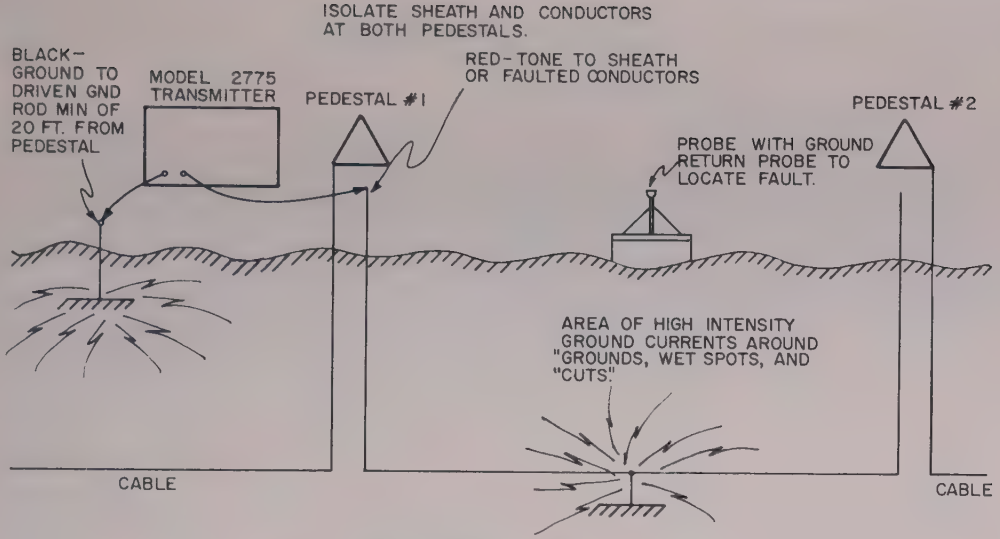


Figure 12. Return Ground Currents Path in "Wets," "Grounds" or "Cuts" and Connection Data

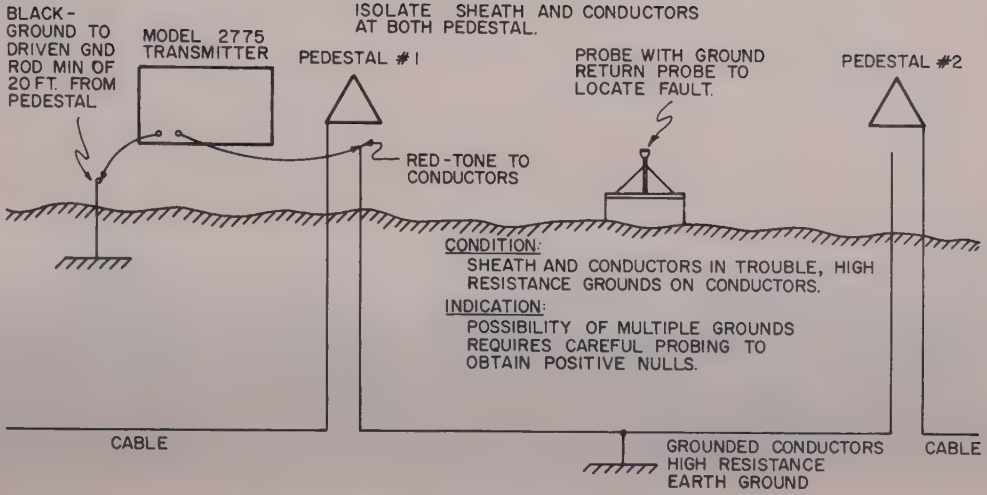


Figure 13. Test and Probing Procedure for High Resistance "Grounds" and "Wets"

General. The various grounding type faults require slight differences in the operation and level setting but do not alter the basic connections or method of probing. The following paragraphs define these differences and bring out points of interest which will help prevent erroneous interpretation of readings.

Sleeve Grounds. Higher readings will be noted when a sleeve ground exists in the buried cable. Correction for this requires careful adjustment of sensitivity or gain at the receiver and may require repetitious adjustment to realize accurate fault location.

Higher Resistance Grounds. Higher level of input and increased level of sensitivity or gain settings will be required on cables with high resistance grounds. Careful probing will be necessary in order that faulted area may be located. (Meter indications of half scale or less are common when probing high resistance faults, consequently the tone is reduced in proportion).

Multiple Faults. Presence of multiple faults "ground," "cuts," and/or "wet spots" in the buried cable plant requires that major faults be identified in one initial probe of cable, repairs made, and a complete recheck of the entire cable path to be certain that additional faults are not present in the form of high resistance "grounds" which could have been masked by the presence of high return ground currents. In addition, it has been found that when "grounds" have occurred in plastic cable the moisture which enters will travel to the lowest point in the cable and possibly cause a high resistance ground due to battery action, etc.

False Indications. It has been found that on occasion, false indications, signified by an abrupt change in the signal strength, when probing the cable path, can occasionally be attributed to variations or change in cable depth. In the event a plateau of high signal intensity, or areas of abrupt change without a definite null indication is encountered, it could be this type of fault. Use of the Snooper Probe to gauge depth in the area will in most cases prove the existence of a change in cable depth.

Proceed with completion of the following steps to locate faults using the Return Ground Probe.

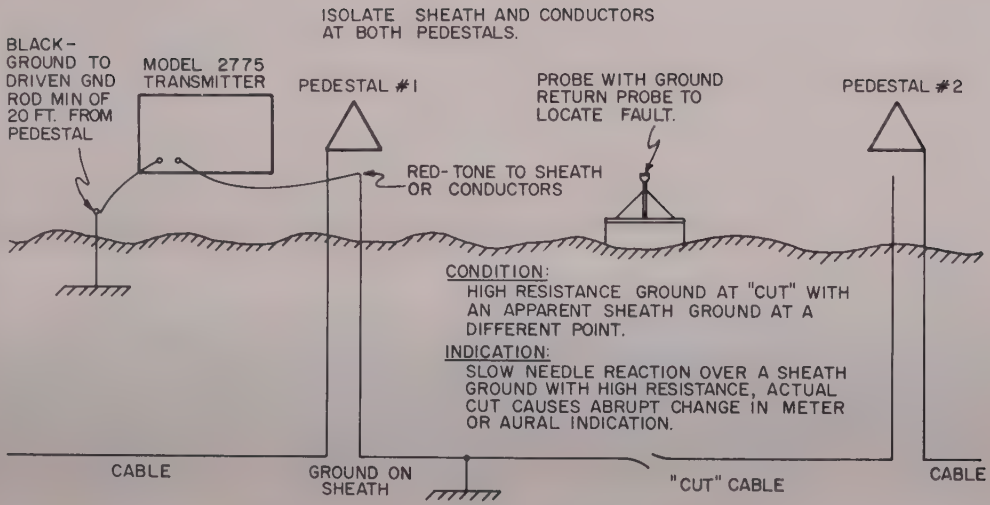


Figure 14. Test and Probing Procedure for "Cuts" with Other "Grounds" (High Resistance)

a. Isolate the faulted conductors and sheath at both pedestals.

b. Connect the faulted conductors or sheath to red terminal of transmitter. (Dependent upon type of fault, i.e. sheath when suspected of being grounded or conductors when it is a high resistance "ground" or "wet spot").

c. Connect a lead from the driven ground rod to the black terminal of transmitter.

d. Complete transmitter adjustment procedures covered in Test Set Adjustments paragraph.

e. Jack the Return Ground Probe into the HI impedance input jack on receiver and adjust receiver in accordance with procedures in Test Set Adjustments paragraph, and the specific instructions given in the subsequent steps.

f. Probe cable path as shown in Figure 15, probing in this manner results in a nominal meter reading and a level of tone as governed by the control settings. (NOTE: Adjust GAIN and VOL controls at a point between 20 and 50 foot from pedestal for most accurate indication and dynamic range of instrument). The level set in at this distance should remain constant until faulted area is reached, at which time a gradual increase will be noted, followed by a sharp cut or drop in the intensity or level. The increase tone is due to increased ground current flow about the fault. Slight movement of the probe either side of this intense area of ground current should indicate a null condition, as shown in Figure 16, and rotating the probe in a 360° arc about the fault should produce an area of intensity equal in level at all angles of probe positioning and the null point will not change. The fault will be found directly under the handle of Return Ground Probe when rotated in this manner. Figure 17 illustrates some of the more common faults.

Location of Faults in Aerial Cables.

Use of the Model 2775 is not limited to buried plant maintenance when accessory probes for aerial trouble-shooting are available. This is to imply accessory probes of other manufacture. At present time RYCOM does not furnish probes for aerial fault location due to the availability of these in most maintenance centers, in conjunction with other test sets. The only care that must be exercised is that impedance matching of probe to receiver is observed in order that optimum gain may

be realized. Control operation of the receiver remains the same and the transmitter operation is the same except for level of tone applied. After matching is determined to the cable under test it has been found that reduction in tone will enable more accurate fault location due to limitation of splatter or crosstalk to the adjacent pairs. For detailed procedures on the location of faults in aerial cable, refer to appropriate BSP or REA maintenance manuals.

MAINTENANCE

With reasonable care in handling of the Test Set, very little maintenance should be required other than occasional battery replacement.

CAUTION

DO NOT PERMIT BATTERIES TO REMAIN IN EQUIPMENT WHEN STORED FOR PROLONGED PERIODS OF TIME. DRY BATTERIES ARE SUBJECT TO LEAKAGE AFTER EXTENDED PERIODS OF STORAGE AND WILL DAMAGE THE EQUIPMENT EXTENSIVELY IF PERMITTED TO REMAIN IN CASE AFTER EXHAUSTED OR DURING PROLONGED STORAGE.

Battery Replacement.

Transmitter: Use Burgess TW2 or equivalent.

CAUTION

DO NOT CONNECT BATTERY IN REVERSE POLARITY - - - CONNECT RED LEAD TO + (POSITIVE) TERMINAL AND BLACK LEAD TO — (NEGATIVE) TERMINAL.

Receiver: Use Eveready #707 or equivalent. Remove the 2 screws at top edge of case and carefully slide receiver out of case to expose battery. Disconnect battery and carefully connect replacement, assembling receiver in reverse order.

Equipment Failure.

In the event equipment fails and all possible checks have been made, loose or broken parts are not apparent, carefully package equipment and return to factory for fast efficient service or replacement. The factory will notify sender on receipt of equipment and the disposition which is to be made.

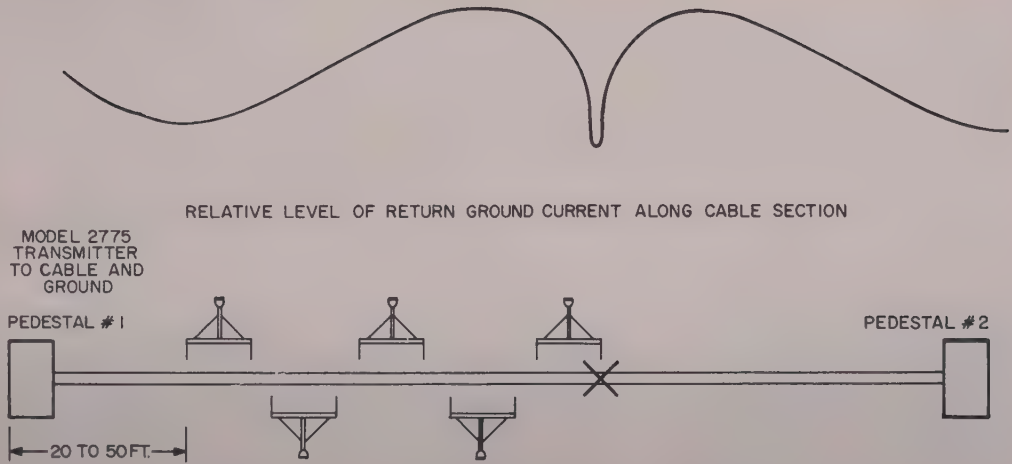

RELATIVE LEVEL OF RETURN GROUND CURRENT ALONG CABLE SECTION
MODEL 2775 TRANSMITTER TO CABLE AND GROUND
PEDESTAL # 1
PEDESTAL # 2
20 TO 50 FT.
NOTE:
PROBING WITHIN 20 TO 50 FT. OF TRANSMITTER MAY RESULT IN ERRORS. IF FAULT IS LOCATED OR SUSPECTED TO BE IN THE PROXIMITY OF TRANSMITTER, CONNECT TRANSMITTER TO OPPOSITE END OF CABLE AND PROBE SUSPECTED AREA.

Figure 15. Method and Procedure for Return Ground Probe and Typical Results

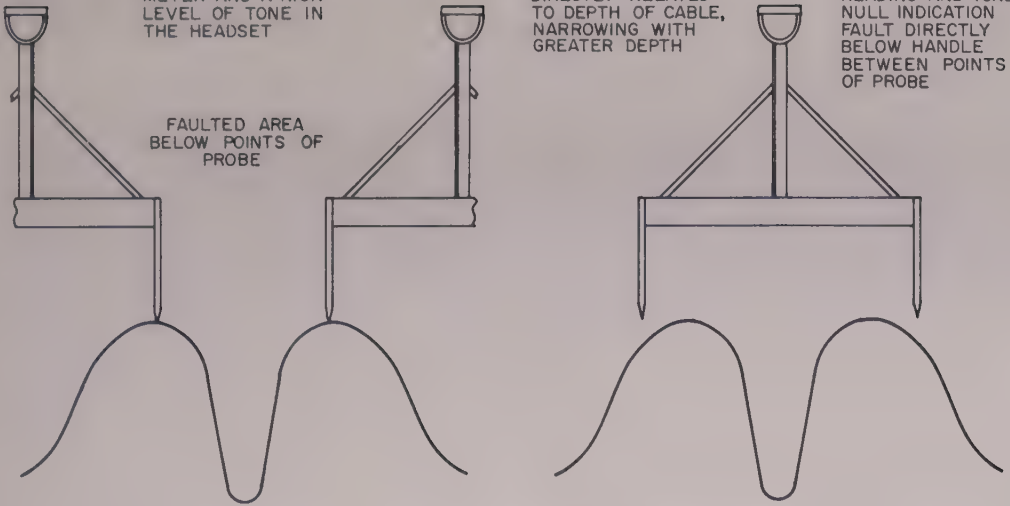

PEAK READING ON METER AND A HIGH LEVEL OF TONE IN THE HEADSET
FAULTED AREA BELOW POINTS OF PROBE
WIDTH OF NULL IS DIRECTLY RELATED TO DEPTH OF CABLE, NARROWING WITH GREATER DEPTH
MINIMUM METER READING AND TONE NULL INDICATION FAULT DIRECTLY BELOW HANDLE BETWEEN POINTS OF PROBE

Figure 16. Method of Probing and Relative Indication with Return Ground Probe at Fault

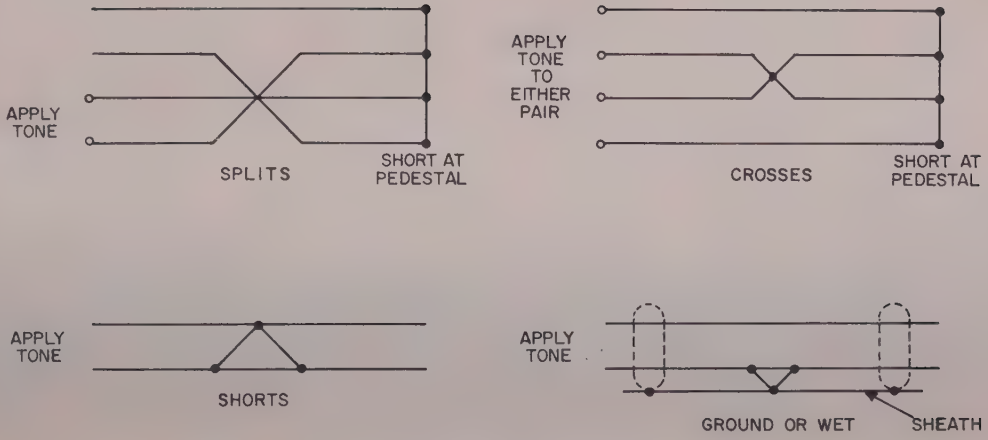


Figure 17. Typical Faults and Methods of Applying Tone

ADDENDUM

To locate openings in shielded aerial cable, it is first necessary to use a capacity type probe (which can be made in your shop). This probe uses a (6) six inch square piece of Galvanized steel, tin, or copper plate. Form this plate into a 'V' and insulate the inside of 'V' so that no physical contact with the cable under test will occur. Attach a single insulated wire to the plate and the other to the TIP side of a jack which will plug into receiver.

In attaching leads from the Model 2775A Transmitter to the open cable it is necessary to use a good side of a pair, which is through from one terminal to the next span terminal. See Figure 18.

Attach tone transmitter as shown in Figure 18, jacking the capacity probe into HI Jack of receiver, turn output of transmitter position to a level setting of '5' so that transmitter meter is swinging mid scale and above. In probing the cable a very weak tone will be heard until you reach the open and your tone will increase very sharply at the point of maximum level you will find the open conductor.

To use this same test on Figure 8 cable or unshielded distribution cable attach tone across the open pair keeping in mind if only one conductor is open to attach the open conductor to the red terminal of the Model 2775A Transmitter. In probing you will find tone down the cable until you reach the open at which point your signal will drop to almost zero.

To locate shorts, wets, and crosses in aerial cable, we have used the Rycom Snooper Probe, Western Electric, Fisher, and Stewart exploring coils, and all may be used with the Model 2775A.

The only difference noted in using the Rycom Fault Locator on aerial cable is that when you have matched your output to the fault, it is necessary sometimes to turn the level control down to prevent flooding at the faulted area, otherwise you could go past your fault if this occurs.

The same practices noted in locating shorts, grounds, etc., as outlined from the Bell System practices or R.E.A. plant maintenance manuals should apply with this instrument.

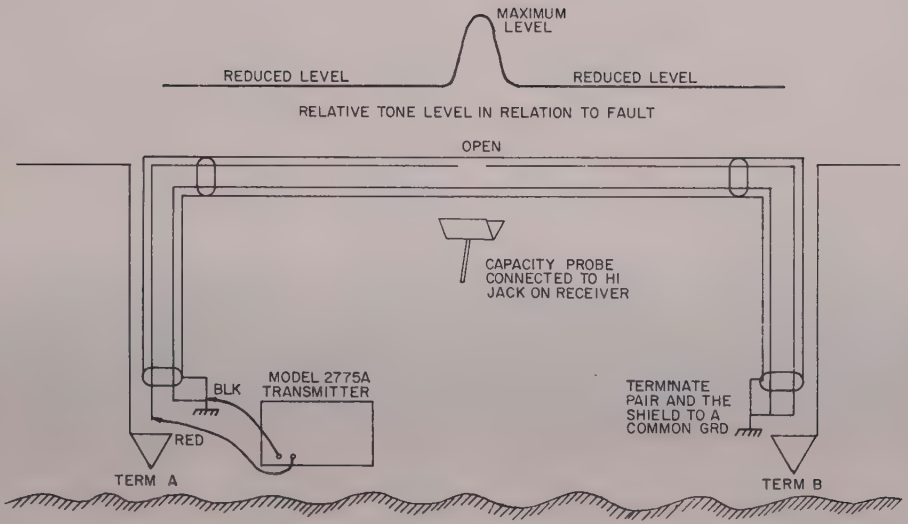


Figure 18. Aerial Cable with Open Conductor

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